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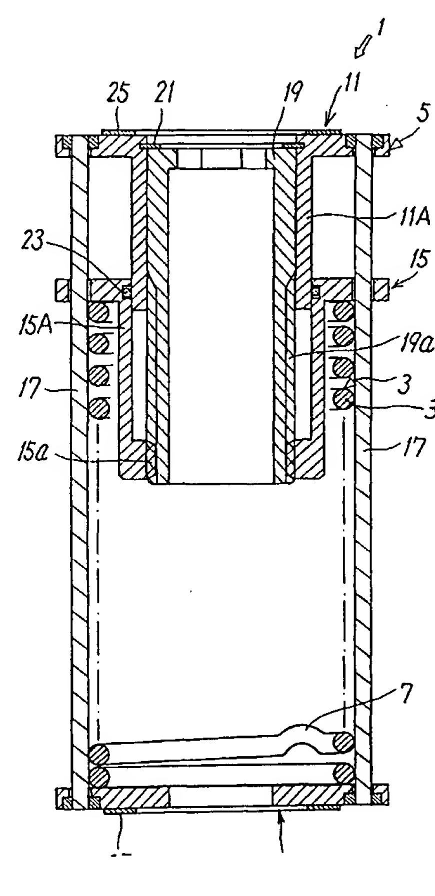
(54) **Filter element**

(57) A filter element 1 for use in filtering a fluid is described. The element includes a filter medium 3 which is axially resiliently expandable to deform filtration gaps therein in response to the expansion. Compression limiting means for produced filtration gaps of required size by limiting the amount of compression applied to the filter medium 3, is held by a holder 5 such that the amount of compression may be adjusted.

FIG. 1



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Descripti n

[0001] The present invention relates to a filter element to be used in a filtering apparatus for filtering a fluid.

[0002] A variety of kinds of filter elements for filtering a fluid having various structures are known. Generally, however, known filter elements are disposable. Even if reusable by cleaning, much time and effort is required because it is hard to remove foreign materials deposited thereon, or sometimes they have to be soaked in a specific chemical agent for a long time to remove the same.

[0003] Therefore, it would be desirable if foreign materials deposited on a filter element could be easily removed and thus the filter element easily recovered for reuse.

[0004] An object of the present invention is to provide filter elements with enhanced handling features and excellent usability which can satisfactorily filter out foreign materials from a fluid and from which deposited foreign materials blocking the filtration gaps can be easily and quickly washed out.

[0005] According to the present invention, a filter element comprising a cylindrical filter medium and a holder for holding the filter medium is provided. The filter medium is constructed to be resiliently expandable in the direction of its axis and to be subject to deformation of the filtration gaps to varying sizes in accordance with the expansion thereof. The filter medium includes a compression limiting means for providing required filtering gaps by limiting the amount of compression applied to the filter medium, and is held by the holder in such a manner that the amount of compression can be adjusted.

[0006] The filter medium is preferably made of a hard resilient material having no compressibility in itself.

[0007] According to a first preferred embodiment, the filter medium is formed by winding a resilient wire rod in a helical fashion including filtration gaps between adjacent wound portions and a plurality of notches for providing the filtration gaps between adjacent wound portions. The notches may be formed by bending parts of the resilient wire rod.

[0008] According to another preferred embodiment, the filter medium is formed by stacking a plurality of annular resilient plates, each plate having a plurality of spring portions for resiliently widening the space between adjacent plates and a plurality of projections for providing filtering gaps between adjacent plates when the filter medium is under compression. The spring portions and projections may be formed by making incisions in the plate and raising up sections thereof.

[0009] According to still another preferred embodiment of the present invention, the filter medium is formed by stacking a plurality of annular spring members and a plurality of annular gap forming members alternately in layers. The spring members are corrugated in the direction of their thickness and are resiliently deformable to the shape of flat plates when the filter medium is under compression. The gap forming members is provided with a plurality of radially extending filtration channels thereon. The filtration channels may be formed on both front and back surfaces of the gap forming members.

[0010] The filter element with the above described configuration is provided with the required filtration gaps when the filter medium is compressed to ensure that a fluid is filtered through these filtration gaps. In order to release the compression of the filter medium for cleaning, the filtration gaps can be expanded sufficiently by manual operation, by means such as an actuator, or by the resilience of a wire rod and/or plates which constitute the filter medium, so that foreign materials deposited on the filter element may be removed easily and satisfactorily.

[0011] In the case where the filter medium is configured in the form of coil of a resilient wire rod, when it is under compression the filtration gaps are provided by notches formed on the resilient wire rod, and when it is removed from the filtering apparatus, the resilient wire rod is expanded because the filter medium is released from the compressed state and thus the filtration gaps widen more or less uniformly.

[0012] In the case where the filter medium is configured by annular resilient plates, when it is under compression the filtration gaps of constant width are provided by means of projections formed on the respective plates, and when it is released from the compressed state, the filtration gaps provided between adjacent plates are widened by the spring portions formed on the respective plates.

[0013] In the case where the filter medium is configured by stacking spring members and gap forming members alternately, when the filter medium is under compression the spring members are flattened into the shape of flat plates and then filtration gaps of uniform width are provided by the filtration channels formed on the gap forming members. When the compression is released, the filtration gaps are widened by restoration of spring members' corrugations.

[0014] Since the filtration gaps of the filter element can be easily widened as described above, foreign materials filtered out may easily be removed by cleaning. In the preferred embodiments in which the filter medium is formed of separate resilient plates or spring members, or of the gap forming members etc., easier cleaning is ensured because the filter medium may be disassembled into pieces for cleaning. In addition, the disassembled members may be reassembl d with relative ease and thus foreign materials may be removed more easily. With such a structure, the filter element itself is readily recoverable and reusable.

[0015] The invention will now be described by way of example and with reference to the accompanying drawings in which:

Fig. 1 is a sectional side elevation view of a filter

element according to the first embodiment of the present invention;

Fig. 2 is a horizontal sectional view of the same filter element;

Fig. 3 is a side elevation view of a resilient wire rod under compression;

Fig. 4 is a side elevation view of the same resilient wire rod in the state where compression is released;

Fig. 5 is a sectional side elevation of a laminated body of plates according to the second embodiment illustrating the compressed state;

Fig. 6 is a plan view of the same laminated body of plates;

Fig. 7 is a sectional side elevation of the same laminated body of plates illustrating the state where compression is released;

Fig. 8 is a sectional side elevation view of a filter element according to the third embodiment;

Fig. 9 is a plan view of the same;

Fig. 10 is a side elevation view of the third embodiment illustrating the state where compression of the laminated body formed of spring members and gap forming members is released;

Fig. 11 is a plan view of the same gap forming member;

Fig. 12 is a grossly enlarged end view of the gap forming member taken on line A-A of Fig. 11; and

Fig. 13 is a plan view of a spring member according to the third embodiment.

[0016] Referring now to the drawings, there are shown some preferred embodiments of a filter element according to the present in detail.

[0017] Fig. 1 - Fig. 4 show a first embodiment of a filter element which is to be mounted in the filtering apparatus for filtering a fluid, comprising, as shown in Fig. 1 and Fig. 2, a cylindrical filter medium 3 which is resiliently expandable in the direction of axis, and a holder 5 for holding the filter medium 3 in the compressed state.

[0018] The filter medium 3 is, as shown in Fig. 2 - Fig. 4, formed by winding a hard resilient wire rod 3a made of material having no compressibility in itself such as metal or ceramics in a helical fashion, and is provided with a designated number of notches 7 per unit turn formed by locally bending parts of the resilient wire rod 3a nearly equidistantly. As clearly shown in Fig. 3, the formation of such notches 7 provides filtration gaps corresponding to the height of the notches 7 between adjacent parts of winding when the filter medium 3 is compressed. Therefore, the notches 7 constitute a compression limiting means for providing required filtration gaps by limiting the amount of compression applied to the filter medium 3. The filter medium 3 is held by the holder 5 with its ends caught between an end plate 13 and a movable plate 15 of the holder 5.

[0019] The holder 5 comprises, as shown in Fig. 1 and Fig. 2, a plurality of guide bars 17 surrounding the filter medium 3 equidistantly, end plates 11, 13 secured to the both ends of these guide bars, and a movable plate 15 mounted to the guide bars between these end plates 11, 13 in inserted state and movable only in directions along these guide bars.

[0020] The end plate 11 is provided with a cylindrical guide cylinder portion 11A extending through the center portion of the holder 5 toward the other end plate 13, and within the guide cylinder portion 11A, a rotating body 19 having a threaded portion 19a on its periphery is rotatably received and retained by a C-frame retaining ring. The movable plate 15 is slidably fitted around the outer surface of the guide cylinder portion 11A of the end plate 11 via a O-ring 23 and has a cylindrical portion 15A extending toward the same direction as the guide cylinder portion 11A, and on the inner surface of the end portion of the cylindrical portion 15A, there is provided a threaded portion 15a for screwing in the threaded portion 19a prepared on the outer surface of the rotating body 19. In this arrangement, by rotating the rotating body 19, the movable plate 15 may be reciprocated along the guide bars 17.

[0021] By placing the filter medium 3 between the end plate 13 and a movable plate 15 and moving the movable plate 15 toward end plate 13 while rotating the rotating body 19, the filter medium 3 is compressed until the position where respective notches 7 come into press contact with adjacent wound portions, and thereby the filter medium 3 is held by a holder under compression with filtration gaps provided between adjacent wound portions by notches 7.

[0022] Reference numbers 25 and 27 in Fig. 1 denote packings mounted on the outer surfaces of the end plates 11 and 13, respectively.

[0023] In the filter element 1 of the first embodiment having above described structure, filtration gaps of the predetermined widths are provided on its side wall by means of notches 7 formed on a resilient wire rod 3a (Fig. 3), and thereby a fluid flowing between the inside and the outside of a cylindrical filter medium 3 is filtered. When the filter medium 3 is resiliently expanded (Fig. 4) by moving the movable plate 15 away from the end plate 13 along the guide bar 17 while rotating the rotating body 19 in the holder, the filtration gaps may be sufficiently widened.

[0024] Therefore, when cleaning the filter element, foreign materials filtered out by the filter element 1 may be removed easily and satisfactory, and thereby the filter element 1 itself may be recovered and reused.

[0025] Referring now to Fig. 5 - Fig. 7, there is shown a second embodiment of the filter element. In the filter element of the second embodiment, a filter medium 33 to be held under compression by the holder 5 is formed by stacking a plurality of annular resilient plates 33A in a cylindrical shape.

[0026] Respective plates 33A are made of a hard material such as metal or ceramics as in the case of the resilient wire rod 3a, and comprise a plurality of spring portions 33a for resiliently widening gaps between ad-

jacent plates 33A and a plurality of projection 33b as compression limiting means for providing required filtration gaps between adjacent plates 33A when the filter medium 33 is compressed. These spring portions 33a and projections 33b are formed by making evenly spaced incisions on the plate 33A in the same direction and raising them up. Respective plates 33A are then stacked on top of each other with the positions of spring portion 33a of adjacent plates 33A staggered alternately by half a pitch to form the laminated body 33.

[0027] Since the holder used in the second embodiment may employ the same structure as the first embodiment, Fig. 1 and Fig. 2 may be referred to know the structure of the holder and thus it is not specifically shown in a figure here.

[0028] In the filter element of the second embodiment with the structure described above, the filter medium 33 formed by stacking annular plates 33A is held by the holder 5 under compression as shown in Fig. 5. At this time, the spring portions 33a of respective plates 33A are deformed to the extent where the projections 33b come into contact with adjacent plates 33A, and thereby between adjacent plates 33A, 33A, there are formed filtration gaps of a width provided by the height of the projections 33b.

[0029] On the other hand, when compression applied to the filter medium 33 is released, as shown in Fig. 7, the filter medium 33 is expanded by resilient restoring force of the spring portions 33a of respective plates 33A, and consequently the filtration gaps between adjacent plates 33A, 33A are widened almost uniformly.

[0030] Accordingly, since the filtration gaps of the filter medium 33 in the filter element may be widened easily, foreign materials filtered out may be removed easily by cleaning.

[0031] Especially, the filter medium 33 of the second embodiment is formed of a plurality of plates 33A which can be disassemble, cleaning may be performed for each individual plate 33A after disassembling them into pieces, which makes removal of foreign materials by cleaning easier. Moreover, restacking of plates in this case is also easy.

[0032] Referring now to Fig. 8 - Fig. 13, there is shown a third embodiment of the filter element. The filter element 61 of the third embodiment is configured in such a manner that the filter medium 63 to be held by the holder 65 under compression is formed in generally cylindrical shape by stacking a plurality of annular spring members 63A and a plurality of annular gap forming members 63B as compression limiting means alternately in layers.

[0033] The spring members 63A are, as seen in Fig. 10 and Fig. 13, corrugated in the direction of thickness so that they may resiliently widen the gaps between adjacent gap forming members 63B when the filter medium 63 is not compressed, and they may be resiliently deformed into flat plates to come into intimate contact with the gap forming members 63B when the filter medium 63 is compressed. In Fig. 13, parts 63c designate upwardly raising convex surfaces, and parts 63d designates downwardly depressed concave surfaces.

[0034] The gap forming members 63B are, as shown in Fig. 11 and Fig. 12, have a plurality of radially extending filtration channels 63b on both front and back surfaces, and the filtration channels on the upper surface 63b are displaced from the filtration channels on the lower surface 63b by half a pitch.

[0035] On the other hand, the holder 65 is, as shown in Fig. 8 and Fig. 9, comprises two end plates 71, 73 for catching the filter medium 63 from both sides, a tension bolt 75 for adjusting the distance between these end plates 71, 73, and a plurality of guide bars 77, 78 for supporting the filter medium 63 from inside.

[0036] On the inner surfaces of the end plates 71, 73, there are provided supporting members 71A, 73A. On one supporting member 71A, one end of the tension bolt 75 is secured by means of nuts 74a, 74b, and on the other supporting member 73A, the other end of the tension bolt 75 is secured by a butterfly nut 74c, and the tension bolt 75 may be expanded and contracted by rotating the butterfly nut 74c to adjust the distance between the end plates 71 and 73.

[0037] The guide bars 77, 78 have a length shorter than the axial length of the holder 65 but longer than a half the axial length thereof, and are mounted on halves to respective end plates 71, 73. In other words, the end plate 71 located at the bottom of the holder is provided with guide bars 77 mounted in the direction of the axis of the holder 65 at equiangular intervals, and the upper end plate 73 is provided with other guide bars 78 mounted at equiangular intervals so as not to cause interference with the guide bars 77. These guide bars 77, 78 support spring members 63A and gap forming members 63B which constitute the filter medium 63 from the inside to maintain their stacked shape.

[0038] The filter medium 63 is disposed between the end plates 71, 73 with the guide bars 77, 78 inserted into the end plates 71, 73, and held between the end plates 71, 73 under compression by tightening the butterfly nut 74c and thereby contracting the tension bolt 75.

[0039] In the filter element 61 of the third embodiment having above described structure, when the filter medium 63 formed by stacking annular spring members 63A and annular gap forming members 63B alternately is compressed by the holder 65, the spring members 63A are flattened and brought into intimate contact with the gap forming members 63B so that a constant filtration gaps are formed by the filtration channels 63b provided on both front and back surfaces of the gap forming members 63B.

[0040] On the other hand, when compression applied by the holder 65 is released, the filtration gaps between adjacent gap forming members 63B are expanded due to restoration of the spring members 63A into corrugated shape.

[0041] The holder 5 of the first and second embodiments and the holder 65 of the third embodiment described above may be used respectively for holding filter medium of other embodiments as well. In other words, the holder 5 may be used also for holding the filter medium 63 of the third embodiment comprising spring members 63A and gap forming members 63B, while the holder 65 may be used for holding the filter medium 3 and 33 of the first and second embodiments as well.

[0042] Especially when the holder 65 of the third embodiment is used for holding the filter medium 33 of the second embodiment, as shown in Fig. 6, a plurality of recesses 33c may be provided radially on the inner radius of the plate 33A so that the guide bars 77, 78 mounted on the holder 65 may be fitted into these recesses 33c. In this case, the recesses 33c are to be formed as many as the number of the guide bars 77, 78.

[0043] The structure of the holder is not limited to those illustrated, and other appropriate structures may be employed provided they can hold the filter medium under compression.

[0044] As described above, the present invention provides a filter element which can satisfactorily filter out foreign materials from a fluid and may be cleaned easily in a short period of time.

Claims

1. A filter element for use in a filtering apparatus for filtering a fluid, the filter element comprising a cylindrical filter medium for filtering fluid while said fluid flows through the side wall thereof and through filtration gaps formed therein, and a holder for holding the filter medium, wherein the filter medium is axially resiliently expandable and the filtration gaps are deformable to greater size in response to the expansion, and wherein the filter medium includes compression limiting means for providing the filtration gaps required for filtering by limiting the amount of compression applied to the filter medium and is held by the holder such as to allow adjustment of the amount of compression.

2. A filter element as claimed in Claim 1, wherein the filter medium is made of a hard resilient material having no innate compressibility.

3. A filter element as claimed in Claim 1, wherein the filter medium is formed by winding a resilient wire rod in helical fashion to include the filtration gaps between adjacent wound portions, and the filter medium is provided with a plurality of notches as said compression limiting means.

4. A filter element as claimed in Claim 3, wherein the notches are formed by bending parts of the resilient wire rod.

5. A filter element as claimed in Claim 1, wherein the filter medium is formed by stacking a plurality of annular resilient plates in layers, each of the plates comprises a plurality of spring portions for resiliently widening the gaps between adjacent plates and a plurality of projections for providing the filtration gaps between adjacent plates when the filter medium is compressed.

6. A filter element as claimed in Claim 5, wherein the spring portions and the projections are formed by making incisions in each plate and raising parts between the incisions.

7. A filter element as claimed in Claim 1, wherein the filter medium is formed by stacking alternately in layers a plurality of spring members and a plurality of compression limiting means in the form of annular gap forming members, the spring members being corrugated and resiliently deformable to a flat plate shape when the filter medium is compressed, and the gap forming members being provided with a plurality of radially extending filtration channels.

8. A filter element as claimed in Claim 7, wherein filtration channels are formed on both front and back surfaces of the gap forming members.

FIG. 1

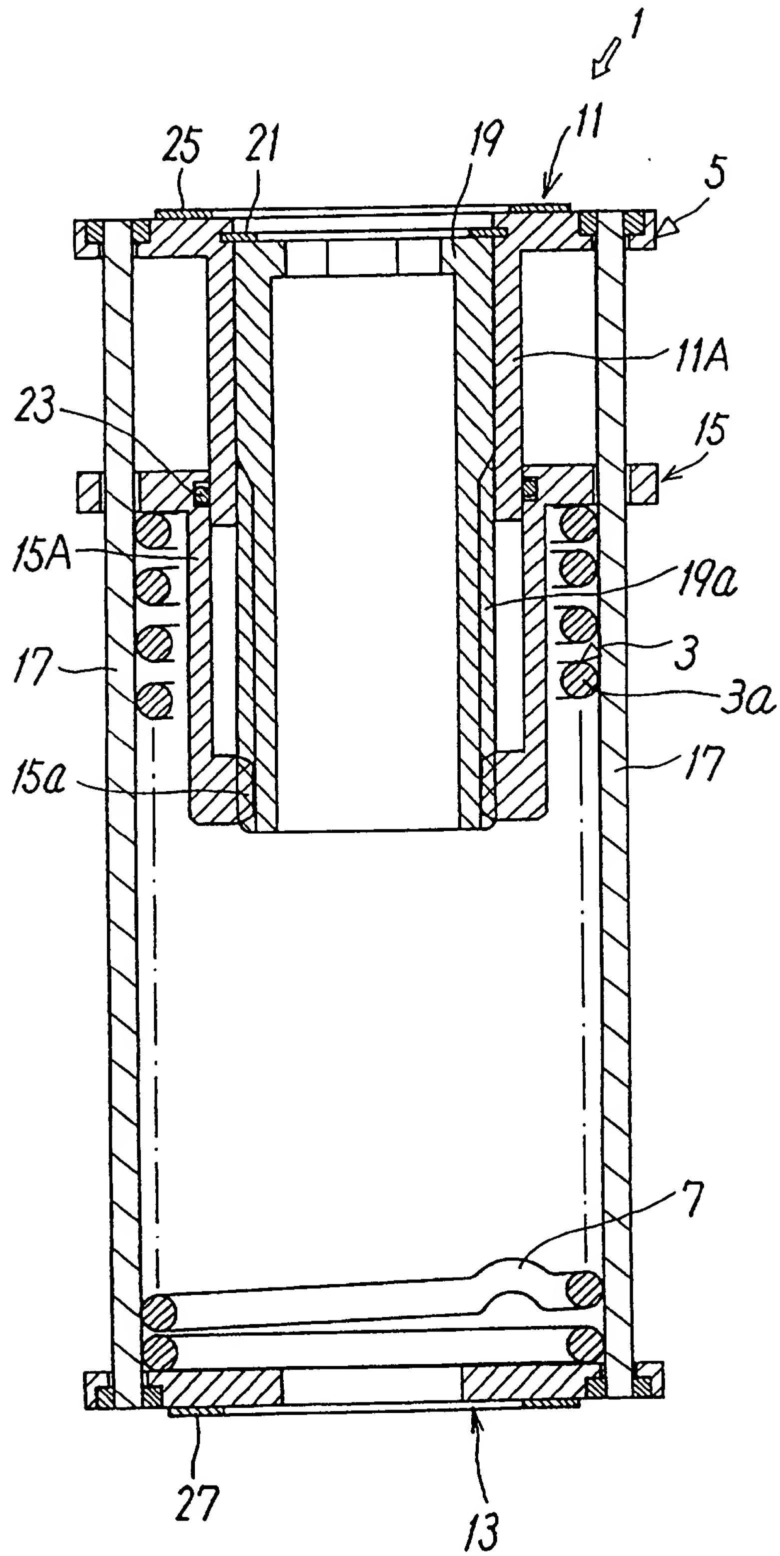


FIG. 2

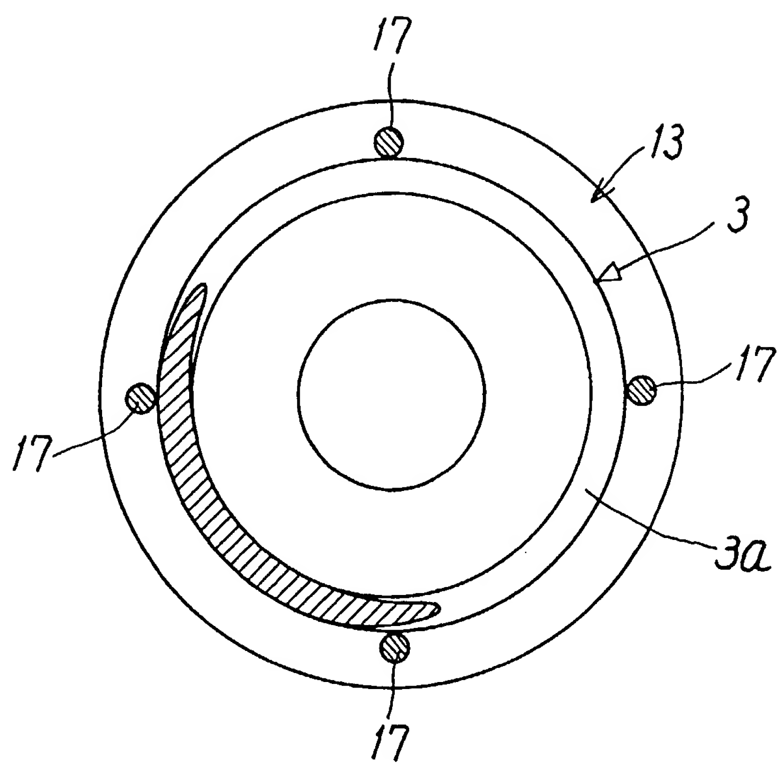


FIG. 3

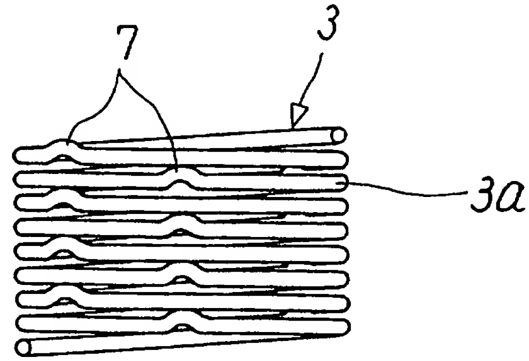


FIG. 4

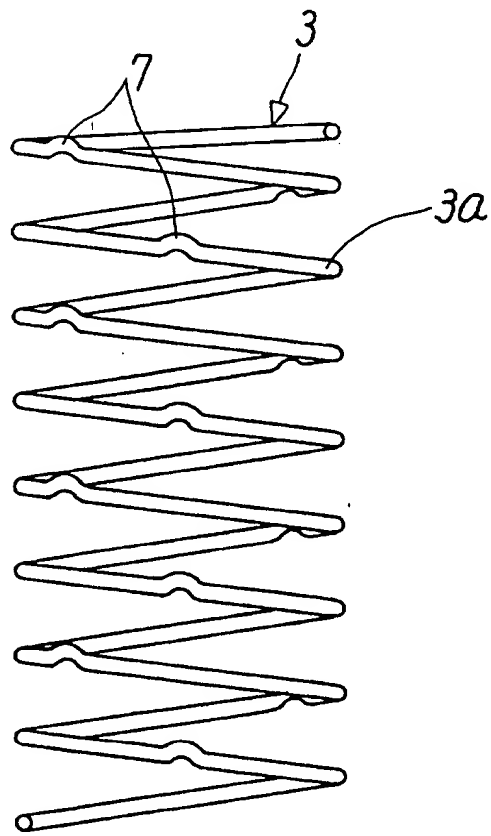


FIG. 5

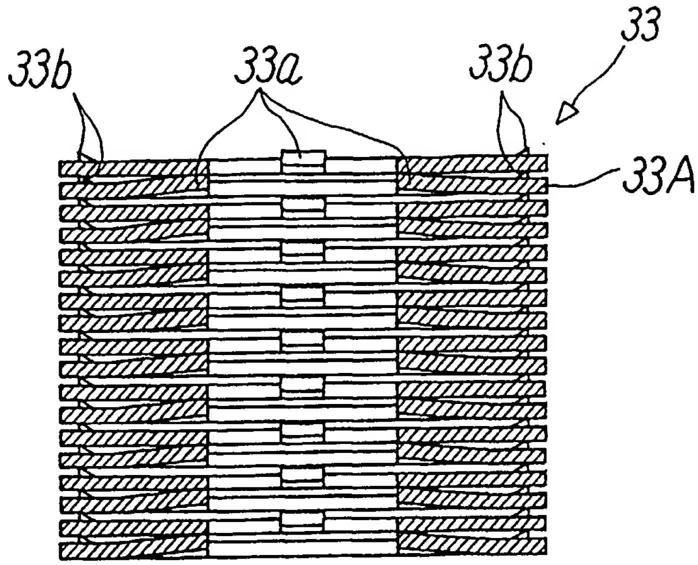


FIG. 6

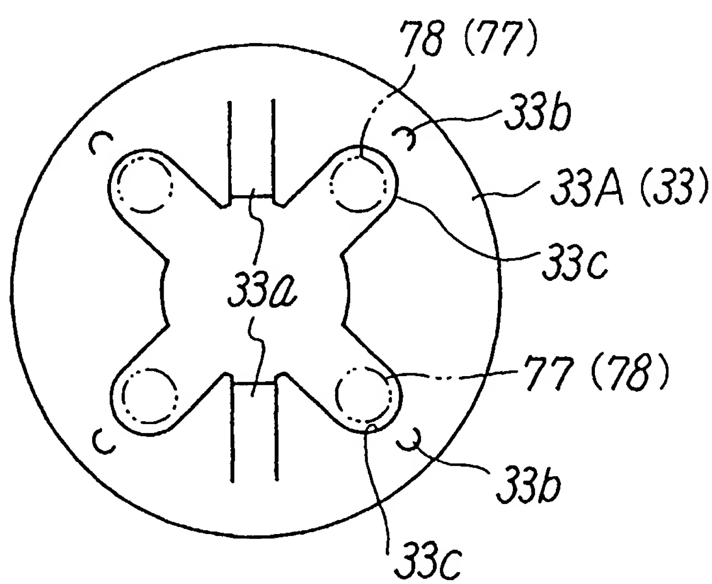


FIG. 7

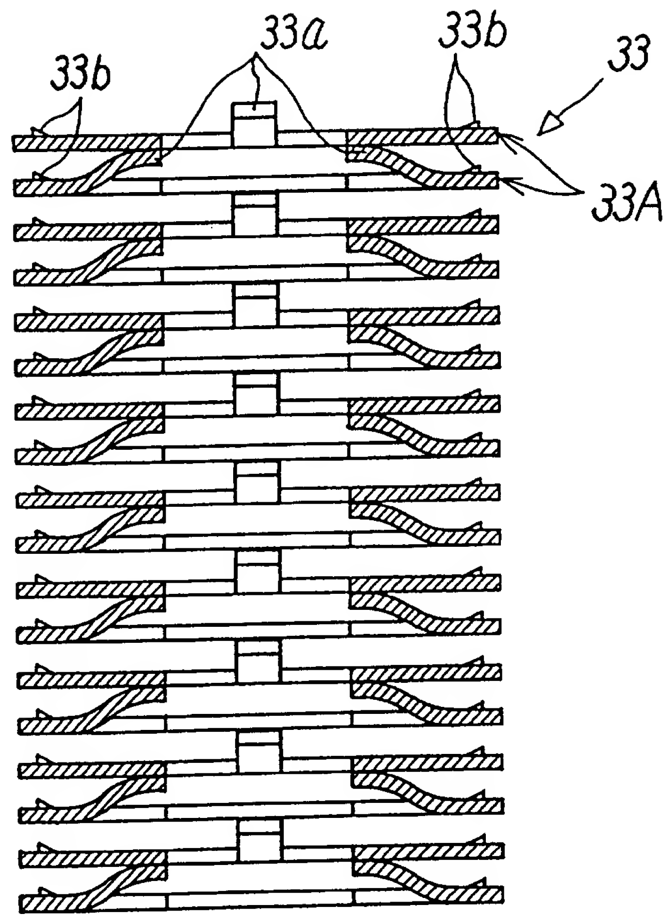


FIG. 8

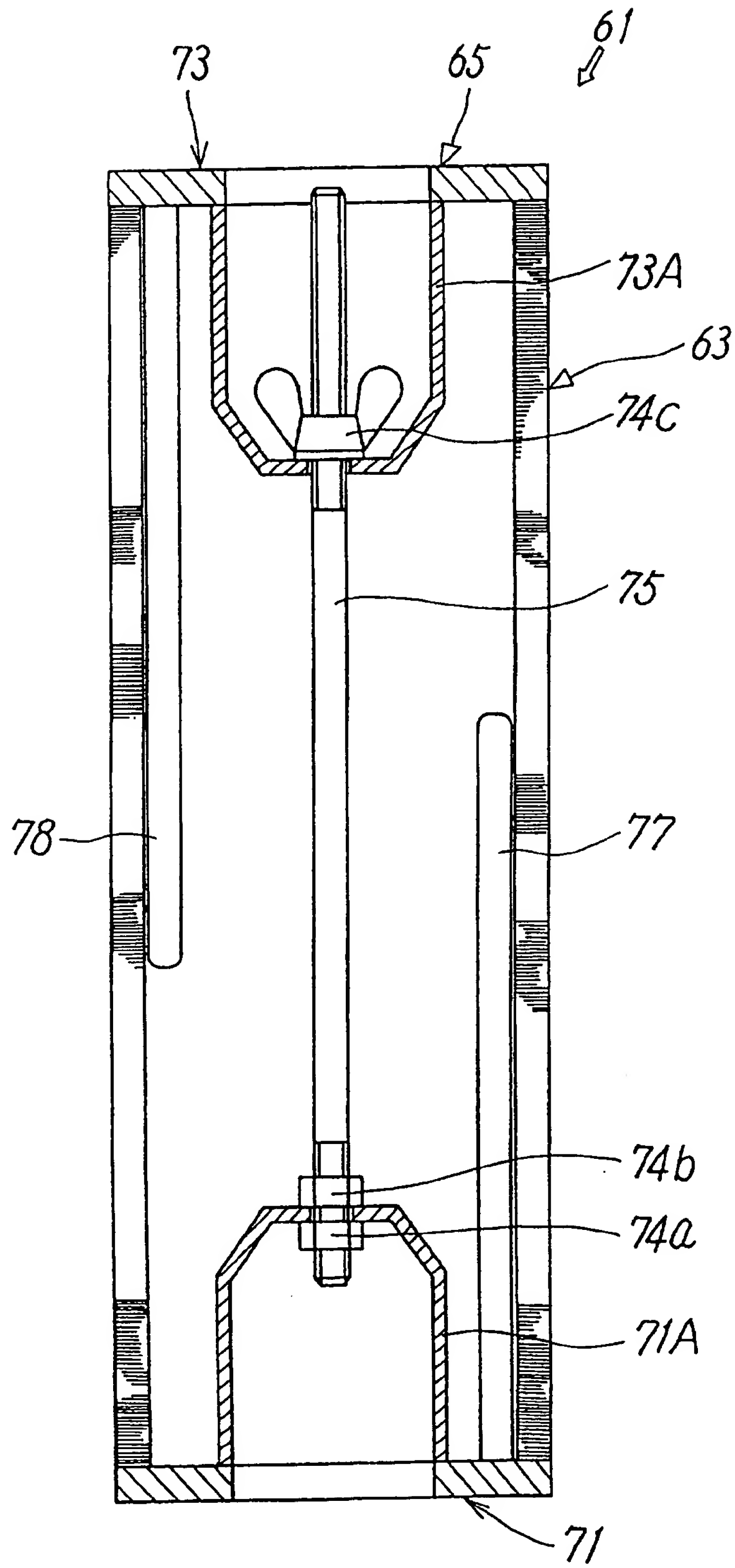


FIG. 9

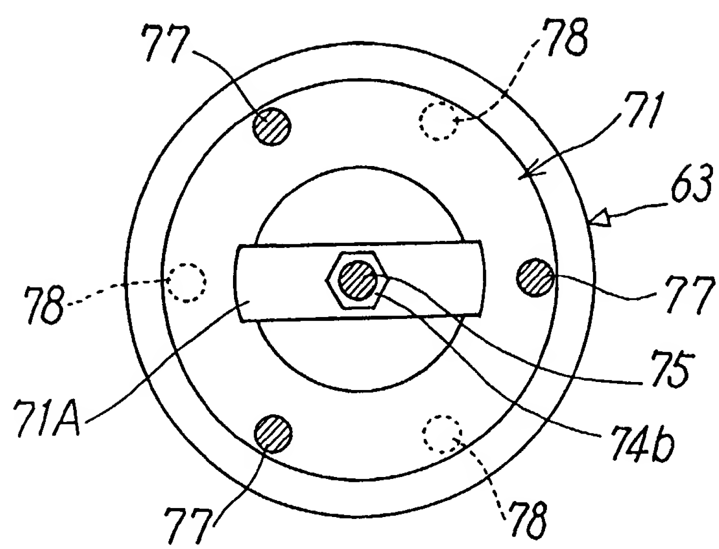


FIG.10

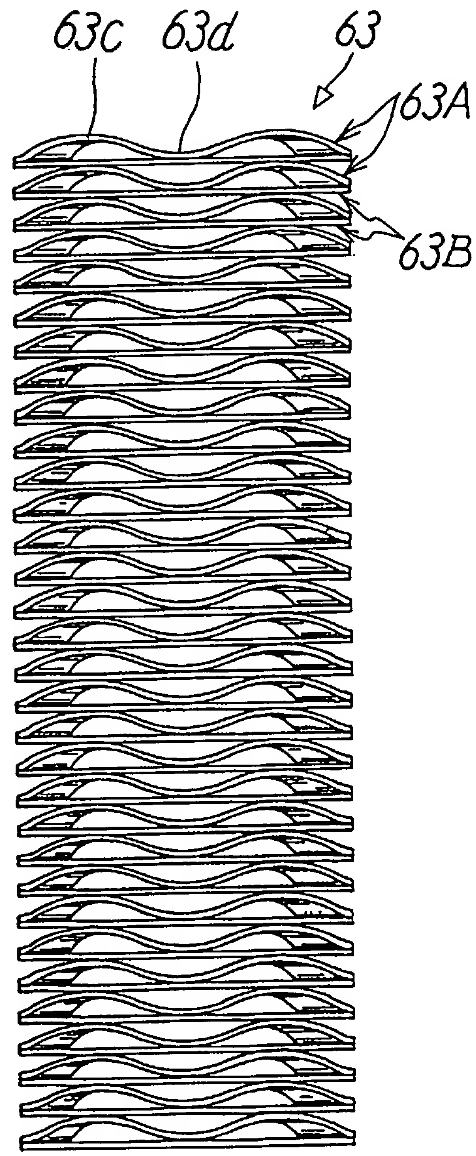


FIG.11

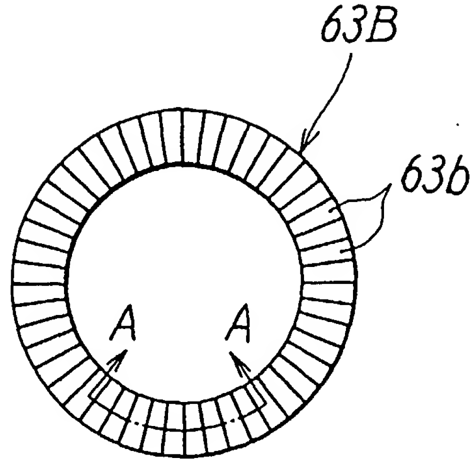


FIG.12

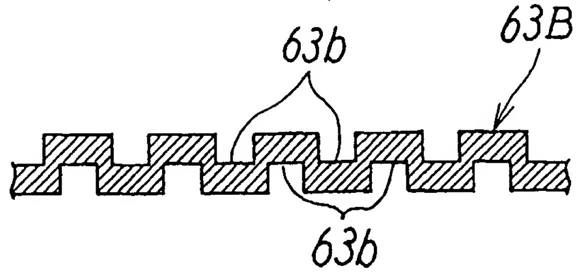
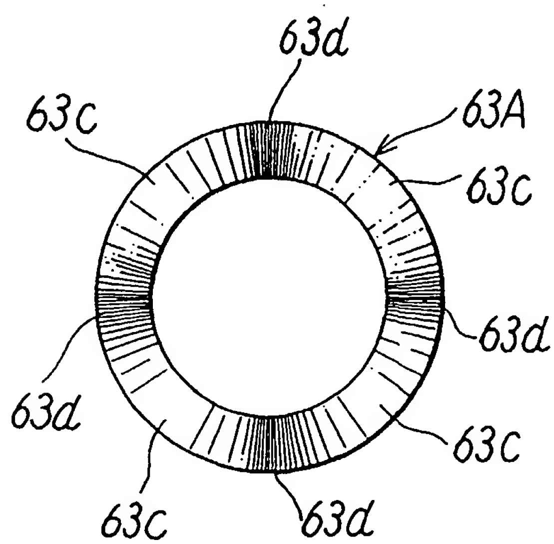


FIG.13



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EUROPEAN SEARCH REPORT

Application Number
EP 99 30 7391

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	3 March 2000	Hoffmann, A

CATEGORY OF CITED DOCUMENTS

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The present search report has been drawn up for all claims

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